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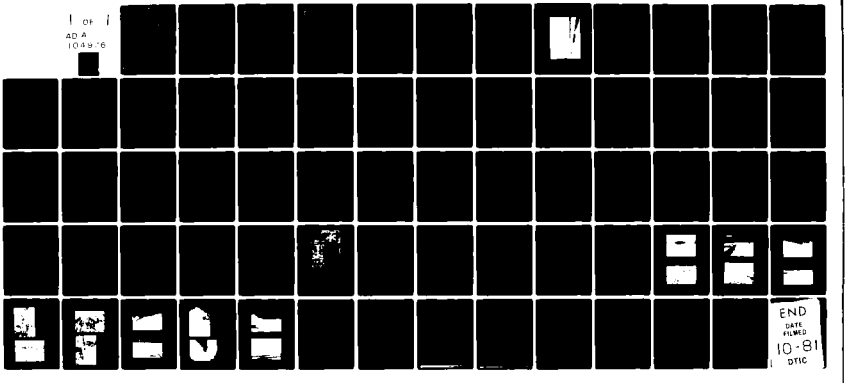

LEVEL II

MISSISSIPPI·SALT·QUINCY RIVER BASIN

KOHL IRRIGATION LAKE NORTH DAM
AUDRAIN COUNTY, MISSOURI
MO. 11210

PHASE I INSPECTION REPORT
NATIONAL DAM SAFETY PROGRAM

United States Army
Corps of Engineers
...Serving the Army
...Serving the Nation

St. Louis District

PREPARED BY: U. S. ARMY ENGINEER DISTRICT, ST. LOUIS

FOR: STATE OF MISSOURI

DECEMBER 1980

UNCLASSIFIED

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19. KEY WORDS (Continue on reverse side if necessary and identify by block number)

Dam Safety, Lake, Dam Inspection, Private Dams

20. ABSTRACT (Continue on reverse side if necessary and identify by block number)

This report was prepared under the National Program of Inspection of Non-Federal Dams. This report assesses the general condition of the dam with respect to safety, based on available data and on visual inspection, to determine if the dam poses hazards to human life or property.

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DEPARTMENT OF THE ARMY
ST. LOUIS DISTRICT, CORPS OF ENGINEERS
210 TUCKER BOULEVARD, NORTH
ST. LOUIS, MISSOURI 63101

REPLY TO ATTENTION OF

SUBJECT: Kohl Irrigation Lake North Dam (Mo. 11210)

This report presents the results of the field inspection and evaluation of the Kohl Irrigation Lake North Dam. It was prepared under the National Program of Inspection of Non-Federal Dams.

SUBMITTED BY: SIGNED — 07 JAN 1981
Chief, Engineering Division — Date

APPROVED BY: SIGNED — 07 JAN 1981
Colonel, CE, District Engineer — Date

KOHL IRRIGATION LAKE NORTH DAM
AUDRAIN COUNTY, MISSOURI

MISSOURI INVENTORY NO. 11210

PHASE I INSPECTION REPORT
NATIONAL DAM SAFETY PROGRAM

PREPARED BY
CONSOER, TOWNSEND AND ASSOCIATES, LTD.
ST. LOUIS, MISSOURI
AND
PRC ENGINEERING CONSULTANTS, INC.
ENGLEWOOD, COLORADO
A JOINT VENTURE

UNDER DIRECTION OF
ST. LOUIS DISTRICT, CORPS OF ENGINEERS
FOR
GOVERNOR OF MISSOURI

DECEMBER 1980

PHASE I INSPECTION REPORT
NATIONAL DAM SAFETY PROGRAM

Name of Dam:	Kohl Irrigation Lake North Dam, Missouri Inventory No. 11210
State Located:	Missouri
County Located:	Audrain
Stream:	Off stream
Date of Inspection:	July 9, 1980

Assessment of General Condition

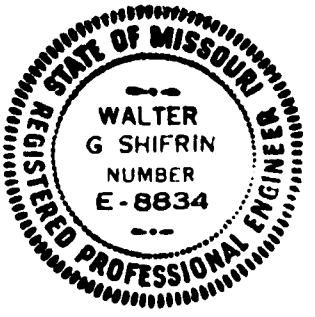
Kohl Irrigation Lake North Dam was inspected by the engineering firms of Consoer, Townsend and Associates, Ltd. of St. Louis, Missouri, and PRC Engineering Consultants, Inc. of Englewood, Colorado, (A Joint Venture) according to the U. S. Army Corps of Engineers "Recommended Guidelines for Safety Inspection of Dams" and additional guidelines furnished by the St. Louis District of the Corps of Engineers. Based upon the criteria in the guidelines, the dam is in the high hazard potential classification, which means that loss of life and appreciable property loss could occur in the event of failure of the dam. Within the estimated damage zone of one mile downstream of the dam are two dwellings, four buildings, one highway, and a trailer, which may be subjected to flooding, with possible damage and/or destruction, and possible loss of life. Kohl Irrigation Lake North Dam is in the small size classification since it is approximately 20 feet high, and impounds more than 50 acre-feet but less than 1,000 acre-feet of water.

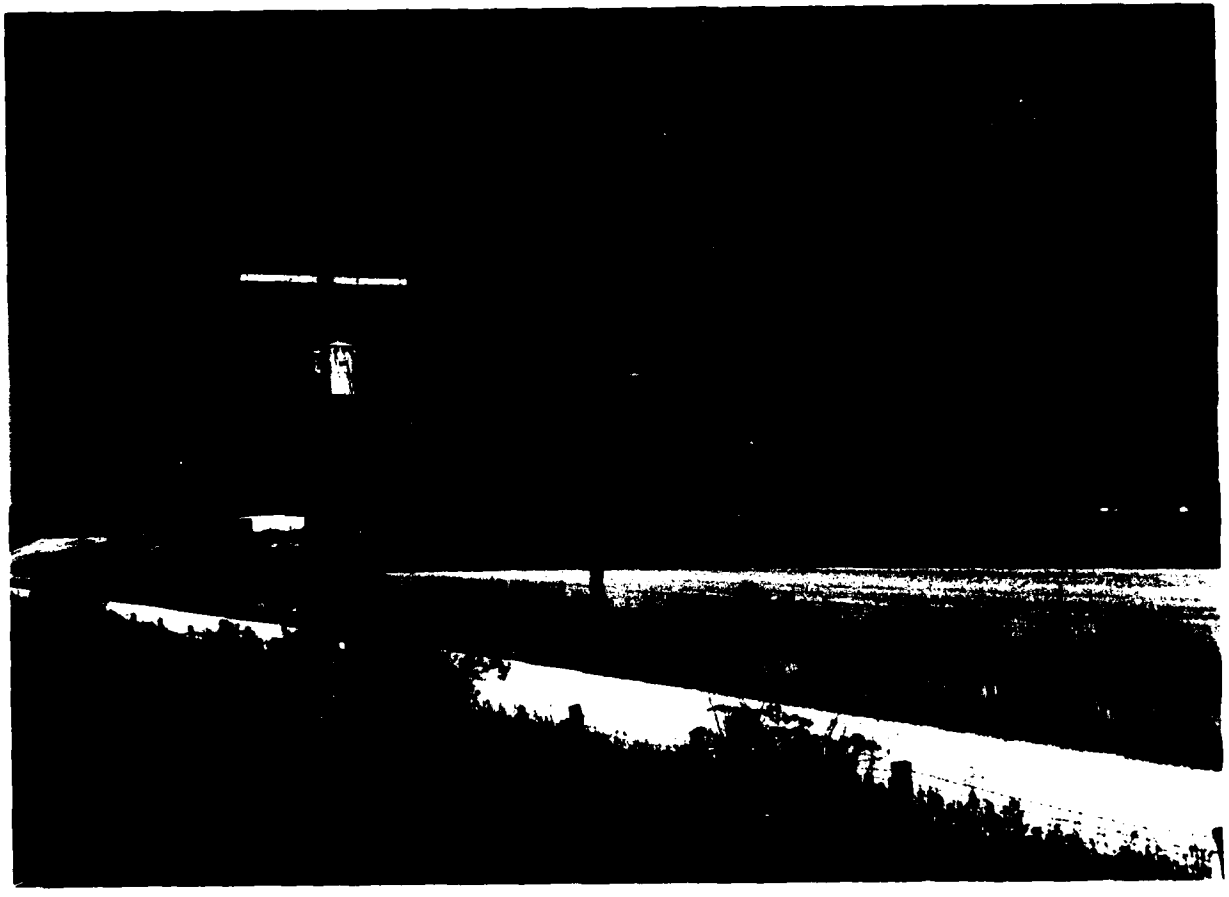
Kohl Irrigation Lake North Dam is a dike that encloses Kohl Irrigation Lake North. No runoff from outside the dam can get into the lake except by means of a pump. The inspection and evaluation by the consultant's inspection team indicate that Kohl Irrigation Lake North can accommodate the Probable Maximum Flood volume without overtopping the dam, if the lake is at normal level during the occurrence of the PMF event. The normal level of the lake, according to the owner of the dam, is three feet below the top of the dam. The evaluation also indicates that Kohl Irrigation Lake North can accommodate the one-percent chance flood (100-year flood) volume without overtopping the dam, if the lake is at normal level during the occurrence of the flood.

The deficiencies with the dam noted by the inspection team were the two areas of possible seepage at the toe of the dam, the cracks on the embankment, the erosion of the upstream slope due to surface runoff and wave action, lack of adequate vegetative cover on the embankment, the damage done to the embankment by vehicular traffic, the large vegetation such as the small trees and bushes observed on the embankment, the partially clogged outlet end of the low level outlet pipe, a need for periodic inspection by a qualified engineer and a lack of maintenance schedule. The lack of seepage and stability on record is also a deficiency that should be corrected.

It is recommended that the owner take action to correct or control the deficiencies described above.

Walter G. Shifrin, P.E.





Overview of Kent Irrigation Lake - North Dam

NATIONAL DAM SAFETY PROGRAM

KOHL IRRIGATION LAKE NORTH DAM, I.D. No. 10210

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PHASE I INSPECTION REPORT
NATIONAL DAM SAFETY PROGRAM

KOHL IRRIGATION LAKE NORTH DAM, Missouri Inv. No. 11210

SECTION 1: PROJECT INFORMATION

1.1 General

a. Authority

The Dam Inspection Act, Public Law 92-367 of August, 1972, authorizes the Secretary of the Army, through the Corps of Engineers, to initiate a national program of dam inspections. Inspection for Kohl Irrigation Lake North Dam was carried out under Contract DACW 43-80-C-0094 between the Department of the Army, St. Louis District, Corps of Engineers, and the engineering firms of Consoer, Townsend & Associates, Ltd., and PRC Engineering Consultants, Inc. (A Joint Venture), of St. Louis, Missouri.

b. Purpose of Inspection

The visual inspection of Kohl Irrigation Lake North Dam was made on July 9, 1980. The purpose of the inspection was to make a general assessment as to the structural integrity and operational adequacy of the dam embankment and its appurtenant structures.

c. Scope of Report

This report summarizes available pertinent data relating to the project, presents a summary of visual observations made during the field inspection, presents an assessment of hydrologic and hydraulic conditions at the site, and the structural adequacy of the various project features, and assesses the general condition of the dam with respect to safety.

Subsurface investigations, laboratory testing and detailed analyses were not within the scope of this study. No warranty as to the absolute safety of the project features is implied by the conclusions presented in this report.

d. Evaluation Criteria

The inspection and evaluation of the dam is performed in accordance with the U.S. Army Corps of Engineers "Recommended Guidelines for Safety Inspection of Dams" and additional guidelines furnished by the St. Louis District office of the Corps of Engineers for Phase 1 Dam Inspection.

1.2 Description of the Project

a. Description of Dam and Appurtenances

The following description is based upon observations and measurements made during the visual inspection and conversations with Mr. Kohl, the owner. One design drawing was provided by Mr. Kohl that shows two proposed layouts of the dam embankment axis and preliminary cut-fill yardage (see Plate 3). However, neither design calculations nor "as-built" drawings were available for the dam or appurtenant structures.

The dam embankment is a compacted homogeneous earthfill structure in an irregular configuration. The dam embankment completely encloses a pumped-storage reservoir. The water stored in the reservoir is either pumped into the reservoir or is from direct rainfall into the enclosure. No runoff flows into the reservoir. The top of dam is typically on the order of 8 feet wide and has a length of 2,556 feet around the perimeter. The crest elevation is assumed to be 764 feet above mean sea level (M.S.L.), and the maximum structural height of the embankment was measured to be about 20 feet. A plan of the embankment is shown on Plate 2 and Photos 1 through 6 show views of the embankment.

The outside slope of the dam varies between 1V on 2.0H to 1V on 2.75H. It was not possible to accurately measure the inside slope because of wave erosion damage to the slope. However, the inside slope where measured was found to be similar to the outside slope. No riprap was placed on the inside slope. Vegetative cover on the embankment is variable in type and density.

There was no spillway constructed for this dam, however, three regulated facilities are utilized at the site. They are a refill pump, a portable irrigation pump and a low level outlet.

The refill pump is an electrically powered, vertical, mixed-flow pump located near the northeast corner of the dam (see Photo 11). This pump, which is operable, pumps water into the reservoir and, according to Mr. Kohl, has a capacity of 6,000 gallons per minute (g.p.m.). The pump motor is situated on top of a 6-foot diameter concrete wet well which has a 27-inch diameter concrete pipe extending from the bottom of the wet well into a water collection pond. The water from the wet well is pumped into the reservoir through a 12-inch diameter steel pipe placed through the embankment (see Photo 2).

The portable irrigation pump is a diesel powered, centrifugal pump and was located, on the day of the inspection, at the southeast corner of the embankment (see Photo 12). This pump pumps water out of the reservoir to be used to irrigate row crops in the area of the dam and, according to Mr. Kohl, has a capacity of 1,000 g.p.m. and is operable. The pump is generally used during the summer months.

The low level outlet consists of a 10-inch steel pipe laid through the embankment and is located about 100 feet south of the northwest corner of the dam (see Photo 13). The outlet is controlled by a gate valve which is located approximately 15 feet from the outlet end of the pipe and is housed in a steel oil drum (see Photo 14). The valve is operable and was operated on the day of the inspection.

b. Location

Kohl Irrigation Lake North Dam is located in Audrain County in the State of Missouri, and is situated offstream at the headwaters of Shady Creek. The small community of Vandalia is about 3/4 mile to the north. The Kohl Irrigation Lake North Dam location on the 7.5 minute series of the U.S. Geological Survey maps is found in Section 17 of Township 52 North, Range 5 West, of the Vandalia, Missouri Quadrangle Sheet.

c. Size Classification

The impoundment of Kohl Irrigation Lake North Dam is less than 1,000 acre-feet but more than 50 acre-feet, and the height is approximately 20 feet. Therefore, the size is determined to fall in the "small" category, according to the "Recommended Guidelines for Safety Inspection of Dams" by the U.S. Deptartment of the Army, Office of the Chief Engineer.

d. Hazard Classification

The dam has been classified as having a "high" hazard potential in the National Inventory of Dams, on the basis that in the event of failure of the dam or its appurtenances, excessive damage could occur to downstream property, together with the possibility of the loss of life. Our findings concur with this classification. Within the estimated damage zone, extending one mile downstream of the dam, are two dwellings, four buildings, one trailer, and a highway.

e. Ownership

Kohl Irrigation Lake North Dam and Reservoir are privately owned by Mr. Fred Kohl. His mailing address is as follows: Route 1, Vandalia, Missouri, 63382.

f. Purpose of Dam

The purpose of the dam is to store pumped water from the adjacent creek for crop irrigation.

g. Design and Construction History

The dam was designed in 1977 by the Department of Agriculture, Soil Conservation Service, of the Mexico, Missouri office. According to Mr. Kohl, the dam was constructed in 1977 by Lamme Excavation Co., of Vandalia, Missouri.

h. Normal Operational Procedures

According to the owner, normal operational procedure is to pump storm runoff (which collects near the northeast toe) into the reservoir when it is low. The drainage from the surrounding property runs along the toe of the dam from the west to the east and then along the east toe of the dam to the downstream channel. No storm runoff can enter the reservoir unless the owner operates the pump located on the northeastern side of the dam. The water level in the reservoir is controlled by irrigation usage, rainfall directly into the reservoir, evaporation, the refill pump, and the hand-operated low level outlet.

1.3 Pertinent Data

a. Drainage Area (acres): 9

b. Elevation (Feet above M.S.L.)

Top of dam:*	764
Normal Pool:	761
Maximum Experienced Pool:	761
Observed Pool:	757

c. Reservoir

Length of pool with water surface at top of dam elevation (feet):	900

d. Storage (Acre-Feet)

Top of dam:	91
Normal Pool:	65.5
Maximum Experienced Pool:	65.5
Observed Pool:	34.7

e. Reservoir Surfaces (Acres)

Top of dam:	9
Normal Pool:	8
Maximum Experienced Pool:	8
Observed Pool:	7.4

f. Dam

Type:	Rolled, Earthfill
Length:	2556 feet
Structural Height:	20 feet
Hydraulic Height:**	20 feet
Top width:	8 feet
Side slopes:	
Outside	Varies between 1V on 2H and 1V on 2.75H

Inside	Varies between 1V on 2H and 1V on 2.75H
Zoning:	Homogeneous
Impervious core:	NA
Cutoff:	4-footdeep and 10- to 12-foot wide cutoff trench (According to Mr. Kohl)
Grout curtain:	None
Freeboard above normal reservoir level:	3 feet
Volume:	95,400 cu.yds. (Estimated)

g. Diversion and Regulating Tunnel. . . . None

h. Regulated Facilities

(1) Refill Pump

Type:	Electrically powered, vertical, mixed-flow pump
Location:	Northeast corner of dam
Maximum Capacity:	6,000 g.p.m. (According to Mr. Kohl)

(2) Portable Irrigation Pump

Type:	Diesel powered, Centrifugal pump
Location:	Southeast corner of dam (on the day of inspection
Maximum Capacity:	1,000 g.p.m. (According to Mr. Kohl)

(3) Low Level Outlet

Type:	10-inch steel pipe
Location:	100 feet south of the Northwest corner of the dam.

* The elevation of the top of dam is assumed from the U.S.G.S. Vandalia, Missouri Quadrangle topographic map. The elevations of other features of the dam are obtained by using this elevation and the field measurements.

** The hydraulic height of the dam is the vertical distance from the lowest point on the downstream toe to the top of the dam or the maximum water surface, if below the top of the dam.

SECTION 2: ENGINEERING DATA

2.1 Design

A design sketch and survey notes were made available from the owner, Mr. Fred Kohl, and the Soil Conservation Service. The design sketch is included in this report (see Plate 3). The surveying data from the Soil Conservation Service is dated March of 1977.

2.2 Construction

No documented data concerning the construction of the dam was available for use in this report, however, information was obtained from Mr. Kohl about the construction of the dam. Mr. Kohl stated that the compaction of the embankment was achieved by the activity of the earth-moving equipment and no compaction control was employed. A 4-foot deep and 10- to 12-foot wide cutoff trench was also provided, according to Mr. Kohl.

2.3 Operation

No operational records are available for the dam.

2.4 Evaluation

a. Availability

The availability of engineering data is poor and consists of a design sketch, SCS survey information, State Geological Maps, a general soils map published by the Soil Conservation Service, and U.S.G.S. Quadrangle Sheets. No data were available with regard to subsurface investigations or soil testing for the dam.

b. Adequacy

The conclusions presented in this report are based on field measurements, the available engineering data, past performance, and present condition of the dam. Seepage and stability analyses comparable to the requirements of the "Recommended Guidelines for Safety Inspection of Dams" were not available, which is considered a deficiency. These seepage and stability analyses should be performed for appropriate loading conditions (including earthquake loads) and made a matter of record.

c. Validity

According to the field measurements, the design sketch was not strictly followed during the construction of the dam. No other valid pertinent data were available.

SECTION 3: VISUAL INSPECTION

3.1 Findings

a. General

A visual inspection of the Kohl Irrigation Lake North Dam was made on July 9, 1980. The following persons were present during the inspection:

Name	Affiliation	Disciplines
Dr. M.A. Samad	PRC Engineering Consultants, Inc.	Project Engineer, Hydraulics and Hydrology
Mark Haynes, P.E.	PRC Engineering Consultants, Inc.	Civil and Mechanical
Razi Quraishi, R.P.G.	PRC Engineering Consultants, Inc.	Geology
Zoran Batchko	PRC Engineering Consultants, Inc.	Soils
Kevin J. Blume	Consoer, Townsend & Assoc., Ltd.	Civil and Structural
Fred Kohl	Owner (Spoken to before the dam inspection)	

Specific observations are discussed below.

b. Dam

The top of dam is generally level with tall and sparse vegetative cover. Shrinkage cracks on the order of 1 to 2 inches wide and 6 to 18 inches deep prevail over most of the top of dam (see Photo 7). These cracks are probably due to moisture depletion of the embankment soil. The shrinkage cracks are generally parallel the dam axis and frequently occur in pairs which are typically located within 2 feet of the embankment faces, respectively. Considerable damage to the top of dam and the embankment due to vehicular traffic has occured. The southeast section of the eastern embankment is heavily rutted with tire tracks up to 8 inches deep (see Photos 4 and 8).

The outside slope of the dam has a dense waist-high vegetative cover on the northern and eastern sides, however, the southern and western slopes have a sparse vegetative cover. Extensive longitudinal and transverse cracking is apparent on the sparsely vegetated sections of the outside slope, especially the southern section adjacent to the top of dam access ramp. Erosion rivulets, up to six inches deep due to surface runoff, were evident on most of the outside face (see Photos 9 and 10).

The inside face of the dam has no riprap protection and has consequently been eroded by wave action. Nearly vertical faces up to 3 feet high and extending to the top of dam were observed (see Photo 2). An approximately 5-foot wide bench has also been formed at the bottom of this vertical face. Shrinkage cracks are also present on the sparsely vegetated inside slope and bench. Both the inside and outside embankment slopes had some small trees and large bushes growing on them.

Two areas of possible seepage are present at the toe of the embankment. However, because both of the wet areas are located in drainage channels and in combination with recent heavy rainfalls in the area, it is not certain that the isolated areas are due to

seepage. One wet and spongy area is located at the northwest corner of the dam about 100 feet north of the low level outlet. The other wet area is located approximately 250 feet south of the structure housing the refill pump at the toe of the eastern portion of the dam (see Photo 5). The area is approximately 10-feet wide and 20-feet long. The drainage channel in which this area is located is generally dry around this wet spot. However, no measurable flows were observed in these areas.

No signs of past or present instability were seen on the embankment or in the foundation. However, several signs were observed on the embankment which could lead to a future instability. The dam has never been overtopped, according to Mr. Kohl and no evidence indicating the contrary was observed. No rodent activity was apparent on the embankment.

c. Project Geology and Soils

(1) Project Geology

The Kohl Irrigation Lake North dam is located in the Dissected Till Plains Section of the central Lowland Physiographic Province. Loess-mantled Kansas drift covers the surface of most of the Dissected Till Plains Section. This section is distinguished from the Young Drift Section to the north and from the Till Plains on the east by the stage it has reached in the post-glacial erosion cycle. Broadly generalized, this section is a nearly flat till plain submature to mature in its erosion cycle.

The topography at the damsite is flat to rolling with U-shaped valleys. Elevations of the ground surface range from 750 feet above M.S.L. at the damsite to 780 feet above M.S.L. approximately two miles south of the damsite.

The regional bedrock geology beneath the glacial outwash deposits in the damsite area as shown on the Geologic Map of Missouri (1979), (see Plate 4), consist of Pennsylvanian Pleasanton-Marmaton-Cherokee Group, Mississippian Burlington Formation, and Chouteau Group rocks, Silurian Bowling Green Limestone, and Ordovician rocks consisting of Noix Limestone and Decorah Formation.

No outcropping of bedrock was observed at the site. The predominant bedrock in the site vicinity underlying the glacial-fluvial deposits are the Pennsylvanian Marmaton-Cherokee Group consisting of cyclic deposits of shale, limestone, and sandstone. The outlet and inlet areas of Shady Creek contains Quaternary alluvium.

No faults have been identified in the vicinity of the damsite. The closest trace of a fault to the damsite is the Cap Au Gres faulted flexure nearly 11 miles east of the damsite. The Cap Au Gres faulted flexure had its last movement in post-Pennsylvanian, pre-Pleistocene time. Thus, this fault has no effect on the damsite.

Kohl Irrigation Lake North Dam consists of a homogeneous earthfill, hexagonal-shaped, enclosed embankment, with two metallic pipes passing through the embanment, the inlet pipe for the refill pump, and the low level outlet pipe.

No boring logs or construction reports were available that would indicate foundation conditions encountered during the construction. Based upon the visual inspection and conservations with Mr. Fred Kohl, the embankment probably rests on the glacial-fluvial deposits (mottled reddish brown to gray, silty clay) with a cutoff trench excavated into the glacial-fluvial deposits. The inlet and the outlet pipes rest on compacted embankment fill.

(2) Project Soils

According to the "Missouri General Soil Map and Soil Association Descriptions" published by the Soil Conservation Service, the materials in the general area of the dam belong to the soil series of Putnam-Mexico in the Central-Claypan area family. The soils are basically formed from loess. These soils are mostly a very slowly permeable silty clay.

Materials were removed from both slopes at various locations around the perimeter. The embankment soils samples obtained appeared to be a mottled red and brown, moderately plastic, clay. Based upon the Unified Soil Classification System, the soil would probably be classified as CL-CH. This soil type generally has the following characteristics: impervious with a coefficient of permeability less than 1.0 foot per year, medium shear strength and a high resistance to piping.

d. Appurtenant Structures

The three regulated facilities at the damsite were operable, reportedly. The low level outlet was operated on the day of the inspecton. No major problems with the three facilities were observed or were apparent. They all appear to be able to function as originally intended. The only condition observed which is of any concern is the partially clogged outlet end of the low level outlet (see Photo 13). The pipe is partially clogged with siltation and vegetation. No seepage was observed in or around the pipe of the low level outlet. Some minor surface rusting of the exposed portion of the discharge pipe for the mixed-flow pump and the pipe of the low level outlet was observed. The intake for the low level outlet was not observed due to the level of the reservoir.

e. Reservoir Area

The reservoir water surface elevation at the time of inspection was 757 feet above M.S.L.

The surface area of the reservoir at the normal water level is approximately 8 acres. The entire reservoir is enclosed by the dam itself. For a description of the problems in the reservoir rim area, see Section 3.1b.

f. Downstream Channel

The downstream channel, which carries storm runoff from areas surrounding the damsite, is a wide, shallow channel. The channel is approximately 100 feet wide and 3 feet deep and has a side slope of approximately 1V on 5H on both sides (see Photo 15). In the case of a dam failure, the reservoir will empty into this channel. Heavy, tall vegetation and trees were observed growing in the channel. These obstructions will significantly reduce the hydraulic efficiency of the channel.

3.2 Evaluation

The visual inspection uncovered nothing of a consequential nature which would require immediate remedial action. However, the following conditions were observed which could adversely affect the dam in the near future.

1. The two areas of possible seepage could affect the structural stability of the dam. It was undetermined, however, if these wet areas were due to seepage or a recent rainstorm. If the wet areas were indeed due to seepage and the rate of seepage were to increase, it is possible that the seepage could transport soil particles from the embankment. This could cause piping of embankment material which could lead to an eventual failure of the embankment.

2. The shrinkage cracks present on the embankment are in need of remedial action. If allowed to go unattended, continued erosion due to surface runoff is expected to precipitate surface sloughing in the areas of the cracking and could eventually lead to a break in the reservoir embankment.

3. The erosion on both the inside face due to wave action and the outside face due to surface runoff do not appear to affect the stability of the embankment in their present condition. However, continual erosion of the slopes can only be detrimental to the stability of the dam.

4. The dense growth of vegetation, which includes the small trees and bushes, in some areas of the embankment should be properly maintained. A tall, dense growth of vegetation on the embankment hinders a comprehensive inspection of the dam and potential problems could go undetected. On the other hand, the areas of sparse vegetation on the embankment can only lead to the deterioration of the embankment. Some deterioration of the embankment has already occurred as indicated by the surface runoff erosion on the outside face.

5. The damage to the embankment due to the vehicular traffic does not appear to affect the safety of the dam in its present condition. However, continued passage of vehicular traffic on the embankment can have an adverse effect on the dam.

6. The partially clogged pipe of the low level outlet does affect the hydraulic capability of the system.

SECTION 4: OPERATIONAL PROCEDURES

4.1 Procedures

Kohl Irrigation Lake North Dam is used to store water for periodic crop irrigation. There are no specific procedures that are followed for the operation of the dam. The water level in the reservoir is controlled by the rate at which water is pumped in, rainfall directly over the reservoir, evaporation, and the rate at which water is pumped to the surrounding crops.

4.2 Maintenance of Dam

The dam is maintained by the owner, Mr. Fred Kohl. Mr. Kohl mentioned that the dam itself receives a limited amount of maintenance. Erosion gullies, transverse cracks, and longitudinal cracks were observed on the embankment. In its present state, the grass cover in some areas appears to be inadequate to protect the embankment slopes.

4.3 Maintenance of Operating Facilities

The operable facilities at the damsite are maintained by the owner, Mr. Fred Kohl. These facilities include the low-level outlet valve, the refill pump and wet well, and the portable irrigation pumping system. The owner informed the inspection team that the refill pump required servicing last winter.

4.4 Description of Any Warning System in Effect

The inspection team is not aware of any existing warning system in effect for this dam.

4.5 Evaluation

The operation and maintenance for Kohl Irrigation Lake North Dam seems to be inadequate. The remedial measures, as described in Section 7.2, should be undertaken as recommended to improve the condition of the dam.

SECTION 5: HYDRAULIC/HYDROLOGIC

5.1 Evaluation of Features

a. Design

The watershed area of Kohl Irrigation Lake North Dam is approximately 9 acres. The watershed area consists essentially of the reservoir surface area. The whole reservoir is enclosed by the dam and water is pumped into the reservoir from the nearby creek.

Evaluation of the hydraulic and hydrologic features of Kohl Irrigation Lake North Dam was based upon criteria set forth in the Corps of Engineers' "Recommended Guidelines for Safety Inspection of Dams" and additional guidance provided by the St. Louis District of the Corps of Engineers. The Probable Maximum Flood (PMF) volume was calculated from the Probable Maximum Precipitation (PMP) using hydrometeorological Report No. 33. Because the reservoir surface area is essentially the entire drainage basin, no PMF hydrograph was calculated. Instead, the 48-hour PMF volume was assumed equal to the 48-hour PMP covering the reservoir surface. The computed flood volume of the PMF is 25 acre-feet; one-half the PMF is 12.5 acre-feet.

According to the owner, Mr. Fred Kohl, the normal water level is approximately 3 feet below the top of the dam. Should the PMF occur when the reservoir is at the normal water level, the dam would not be overtopped.

The reservoir stage-capacity data were based on the field notes in combination with data provided by the owner. The reservoir capacity curve is presented in Appendix B.

From the standpoint of dam safety, the hydrologic design of a dam must aim at avoiding overtopping. Overtopping is especially dangerous for an earth dam because of its erodable characteristics. The safe hydrologic design of an embankment dam requires an embankment crest height that can handle a very large and exceedingly rare flood without overtopping.

The Corps of Engineers designs dams to safely pass the Probable Maximum Flood that could be generated from the dam's watershed. This is generally the accepted criterion for dam safety where overtopping would pose any threat to human life. Accordingly, the hydrologic requirement for safety for this dam is the capability of the reservoir to contain the Probable Maximum Flood volume without overtopping.

b. Experience Data

It is believed that records of reservoir stage are not maintained for this site. However, according to the owner, the maximum reservoir level was approximately 3 feet below the top of the dam.

c. Overtopping Potential

As indicated in Section 5.1a, the Kohl Irrigation Lake North Dam can contain the Probable Maximum Flood volume, if the PMF event occurs when the reservoir is at normal level. The reservoir can accommodate the half PMF volume with a freeboard of 1.4 feet.

The failure of the dam could cause extensive damage to the property downstream of the dam and possible loss of life. There are two dwellings, one highway, four buildings, and a trailer within the estimated damage zone, which extends approximately one mile downstream of the dam.

SECTION 6: STRUCTURAL STABILITY

6.1 Evaluation of Structural Stability

a. Visual Observations

There were no major signs of settlement observed on the embankment or foundation during the visual inspection. However, several items of distress were observed. The inside slope is not adequately protected from wave erosion; extensive shrinkage cracking prevails over most of the exposed embankment; two areas of possible seepage were observed at the toe of the embankment; surface runoff rivulets were observed on the outside slope; all of which do or could jeopardize the stability of the embankment. In the absence of seepage and stability analyses, no quantitative evaluation of the structural stability can be made.

The low-level outlet and the structure housing the refill pump appeared to be structurally stable on the day of the inspection.

b. Design and Construction Data

The design drawings presented as Plate 3 had no usage in the overall assessment of the structural stability of the dam. Design computations pertaining to the embankment or appurtenant structures were not available during the report preparation phase. Seepage and stability analyses comparable to the requirements of the "Recommended Guidelines for Safety Inspection of Dams" were not available. No embankment or foundation soil parameters were available for carrying out a conventional stability analysis on the embankment. No construction data or specifications relating to the degree of embankment compaction were available for use in a stability analysis.

c. Operating Records

No operating records were available relating to the dam or appurtenant structures. The water level on the day of the visual inspection was approximately 7 feet below the top of the dam. The normal water level, according to Mr. Fred Kohl, is approximately 3 feet below the top of the dam. Mr. Kohl also stated that the maximum water level in the reservoir was the same as the normal water level.

d. Post Construction Changes

No post construction changes to the embankment are known to exist which will affect the structural stability of the dam.

e. Seismic Stability

The dam is located in Seismic Zone 1, as defined in "Recommended Guidelines for Safety Inspection of Dams" prepared by the Corps of Engineers, and will not require a seismic stability analysis. An earthquake of the magnitude that would be expected in Seismic Zone 1 will not cause distress to a well designed and constructed earth dam. Available literature indicates that no active faults exist near the vicinity of the damsite.

SECTION 7: ASSESSMENT/REMEDIAL MEASURES

7.1 Dam Assessment

The assessment of the general condition of the dam is based upon available data and visual inspection. Detailed investigations, testing, and detailed computational evaluations are beyond the scope of a Phase I investigation; however, the investigation is intended to identify any need for such studies.

It should be realized that the reported condition of the dam is based upon observations of field conditions at the time of inspection along with data available to the inspection team.

It is also important to note that the condition of a dam depends upon numerous and constantly changing internal and external conditions, and is evolutionary in nature. It would be incorrect to assume that the present condition of the dam will continue to represent the condition of the dam at some point in the future. Only through continued care and inspection can there be assurance that an unsafe condition could be detected.

a. Safety

Kohl Irrigation Lake North Dam encloses the entire reservoir area. The reservoir can accommodate the Probable Maximum Flood volume without overtopping the dam if the PMF event occurs when the reservoir is at normal level. The dam is considered hydrologically adequate. The reservoir should never be filled above the normal level by the refill pump. In case of a storm, which raises the reservoir level above the normal water level, the reservoir should be immediately drawn down to the normal level.

Physically the dam appears to be in poor condition. The wave erosion of the inside face extending up to the crest in combination with prevalent shrinkage cracks pose a hazard to the dam. A quantitative evaluation of the safety of the embankment could not be made in view of the absence of seepage and stability analyses. The present embankment and appurtenant structures, however, reportedly have performed satisfactorily since their construction; there have been no failures or evidence of instability. Reportedly, the dam has never been overtopped and no evidence indicating the contrary was observed. The safety of the dam can be improved if the deficiencies as described in Sections 3.2 and 6.1a are properly corrected as described in Section 7.2.

b. Adequacy of Information

The conclusions presented in this report are based upon field measurement, past performance, and the present condition of the dam. Information on the design hydrology, hydraulic design, and operation and maintenance of the dam was not available. Seepage and stability analyses comparable to the requirements of the "Recommended Guidelines for Safety Inspection of Dams" were not available, which is considered a deficiency.

c. Urgency

The remedial measures recommended in Paragraph 7.2 should be accomplished within a reasonable period of time.

d. Necessity for Phase II Inspection

Based upon results of the Phase I inspection, a Phase II inspection is not felt to be necessary.

7.2 Remedial Measures

The following remedial measures should be undertaken by an engineer experienced in design and construction of earth dams within a reasonable period of time in order to improve the condition of the dam.

1. The two areas of possible seepage should be further investigated to determine if the conditions are due to seepage or a recent rainstorm. If the conditions are indeed due to seepage, the areas should be monitored to detect any changes in location, turbidity, and quantity of water. Any changes should be reported and investigated further.

2. The cracking observed on the embankment should be properly repaired and the embankment monitored for further cracking to ensure the safety of the dam.

3. The erosion due to surface runoff and wave action should be properly backfilled and the areas properly protected to prevent further damage.

4. An adequate vegetative cover should be provided on the embankment to protect it from surface erosion and the vegetation should be properly maintained so that potential problems with the embankment do not go undetected.

   The large vegetation, such as the small trees and bushes observed on the embankment, should be removed from the embankment and prevented from growing back.

5. The damage to the embankment cuased by the vehicular traffic should be properly repaired and an adequate surfacing provided to accommodate vehicular traffic without causing further damage.

6. The outlet end of the low level outlet pipe should be unclogged and kept free of any siltation in the future. The gate valve for the outlet should also be periodically operated and properly maintained as recommended by the valve manufacturer.

7. Seepage and stability analyses should be performed by a professional engineer experienced in the design and construction of earth dams.

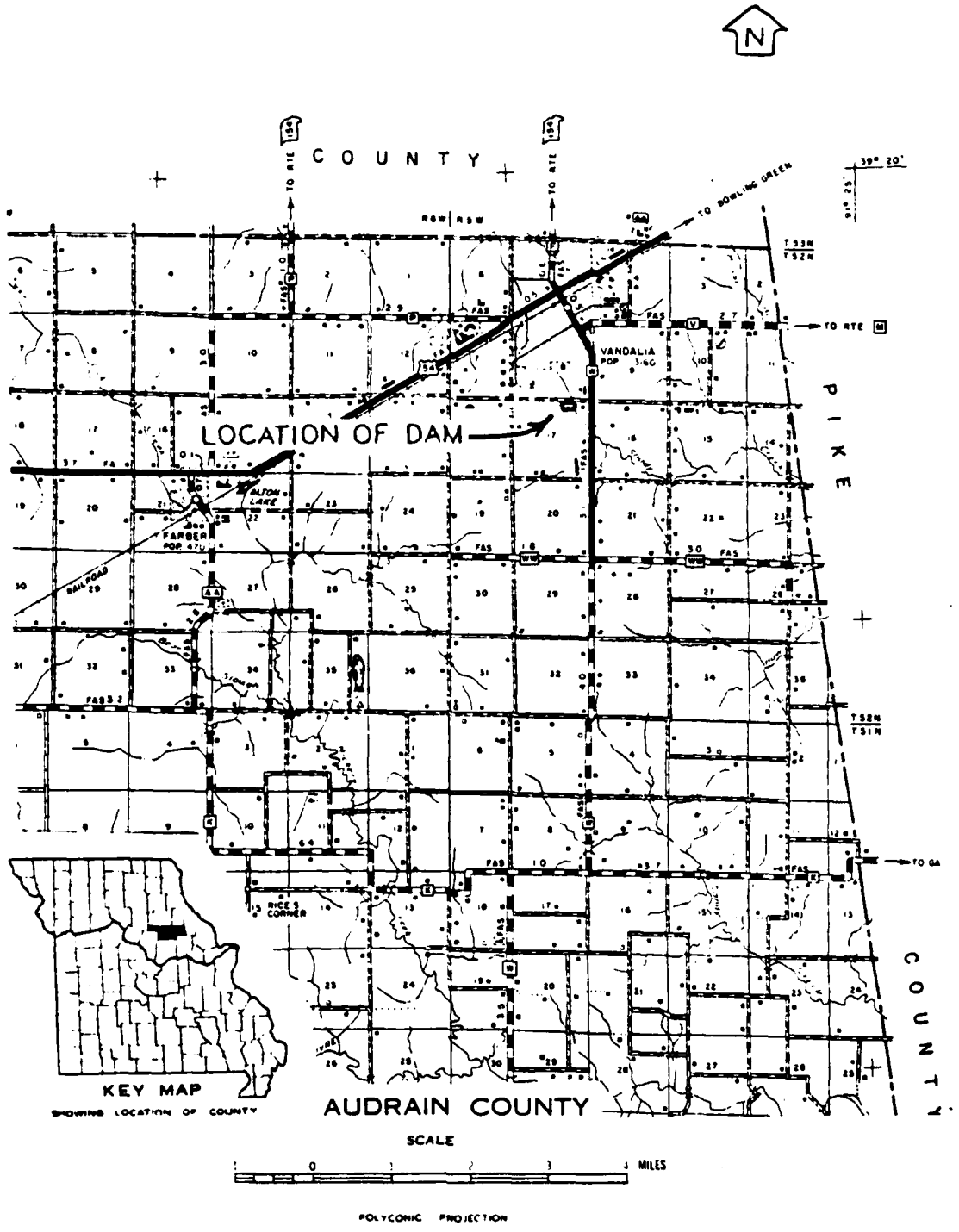
8. The owner should initiate the following programs:

   (a) Periodic inspection of the dam by a professional engineer experienced in the design and construction of earth dams.

   (b) Set up a maintenance schedule and log all visits to the dam for operation, repairs, and maintenance.

PLATES

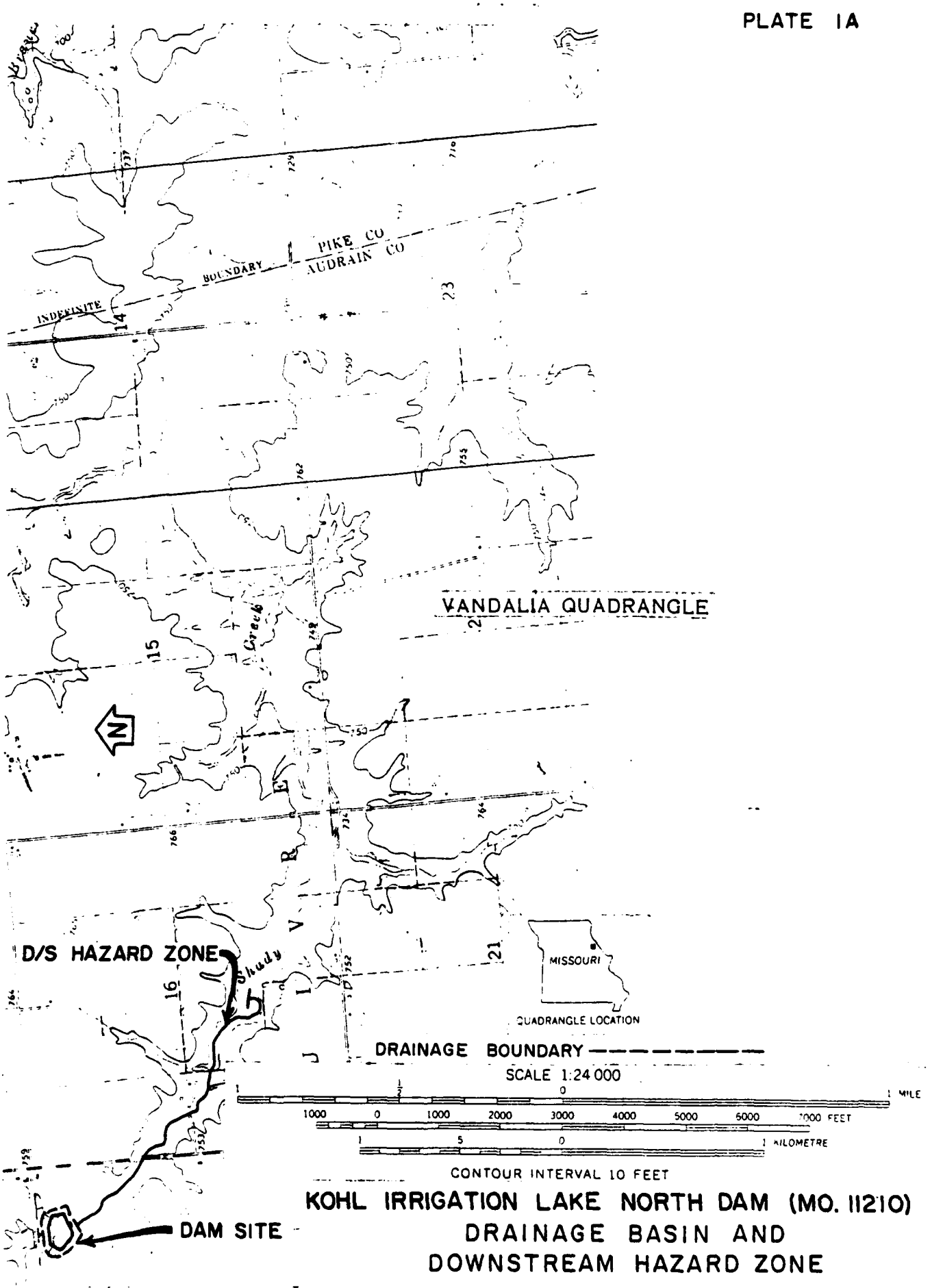
PLATE 1



LOCATION MAP - KOHL IRRIGATION LAKE NORTH DAM

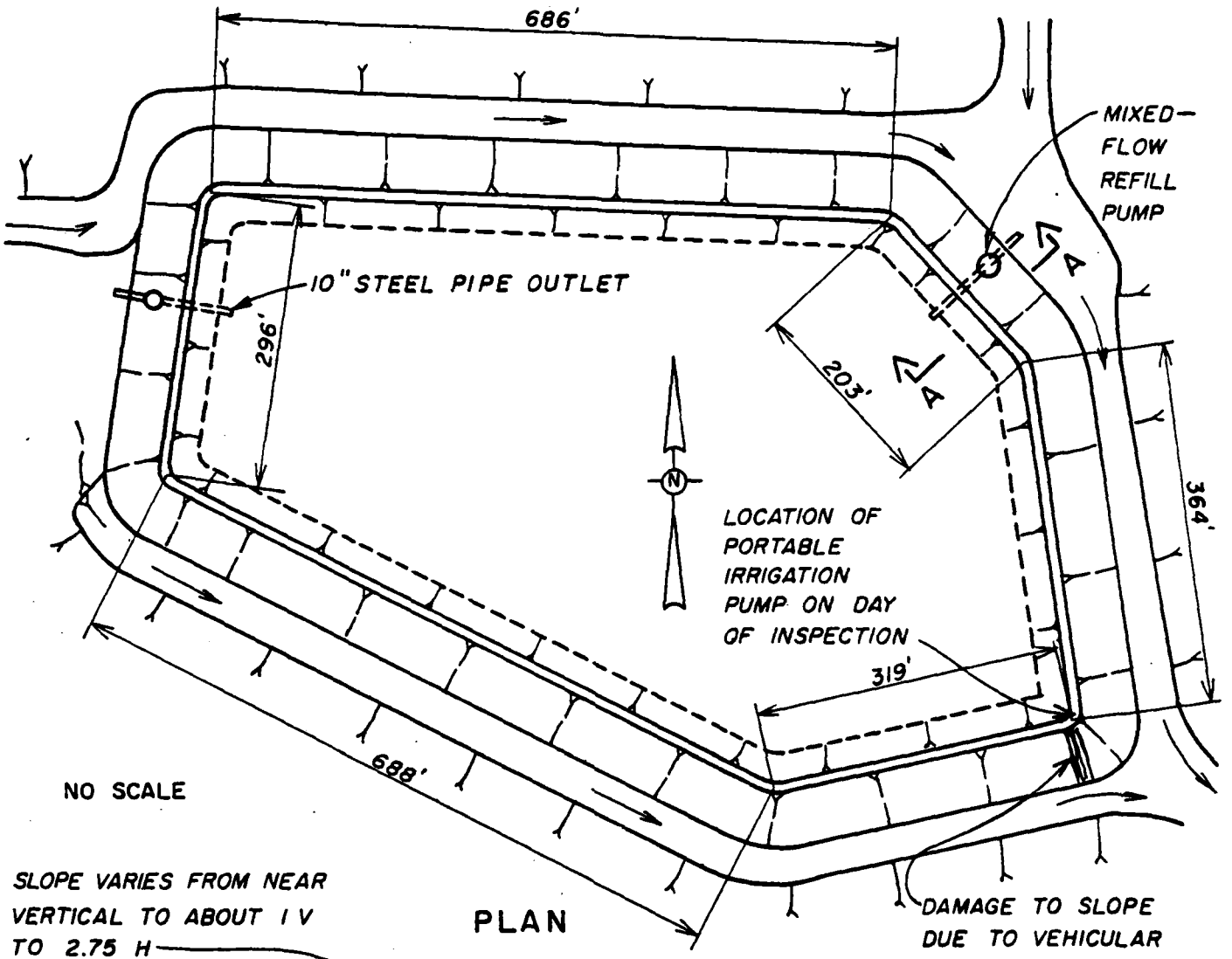
MO.11210

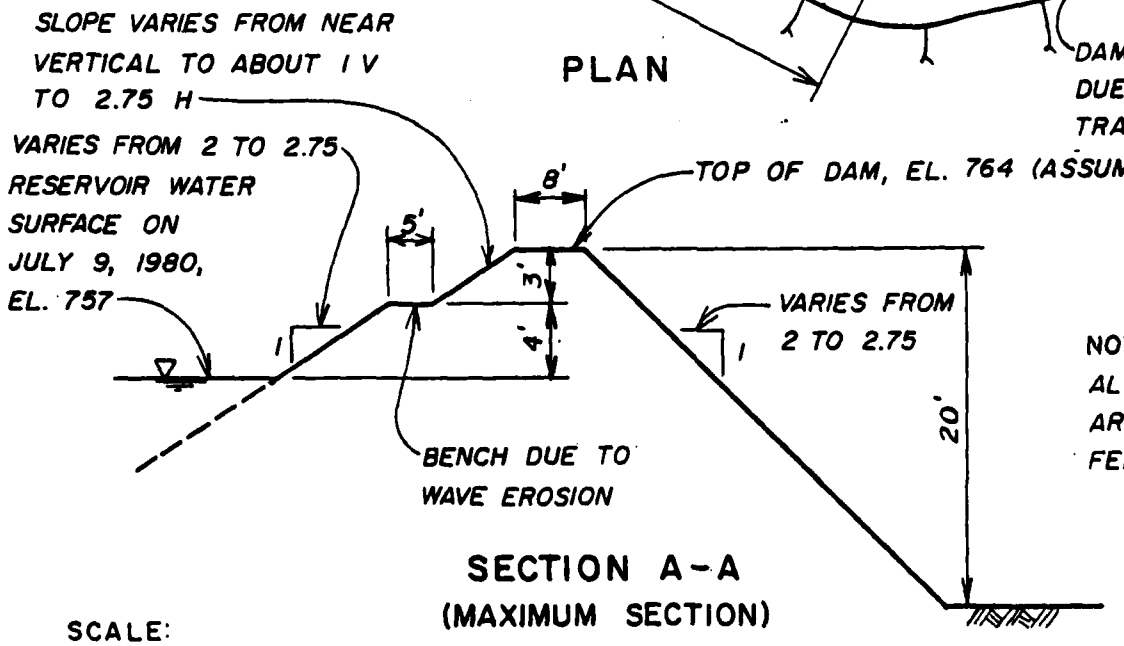
PLATE 1A



KOHL IRRIGATION LAKE NORTH DAM (MO. 11210)
DRAINAGE BASIN AND DOWNSTREAM HAZARD ZONE

PLATE 2





NOTE:
ALL ELEVATIONS ARE SHOWN AS FEET ABOVE M.S.L.

SECTION A-A
(MAXIMUM SECTION)

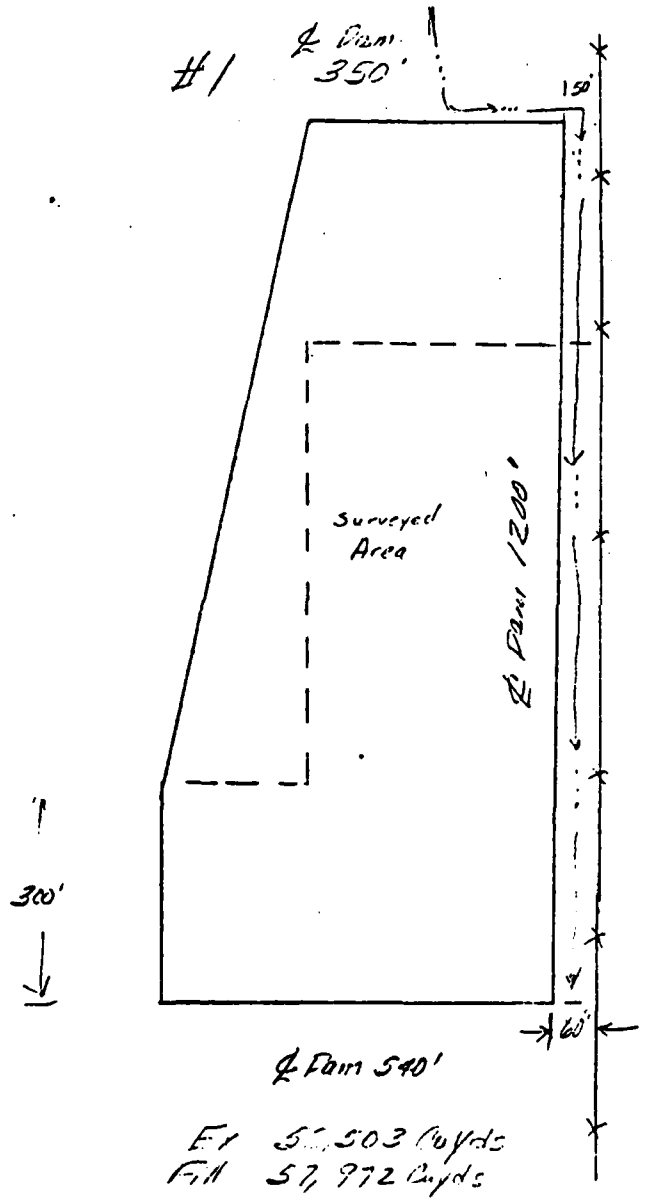
SCALE:
HORIZ. 1"= 20'
VERT. 1"= 10'

KOHL IRRIGATION LAKE NORTH DAM (MO. 11210)
PLAN AND MAXIMUM SECTION

PLATE 3

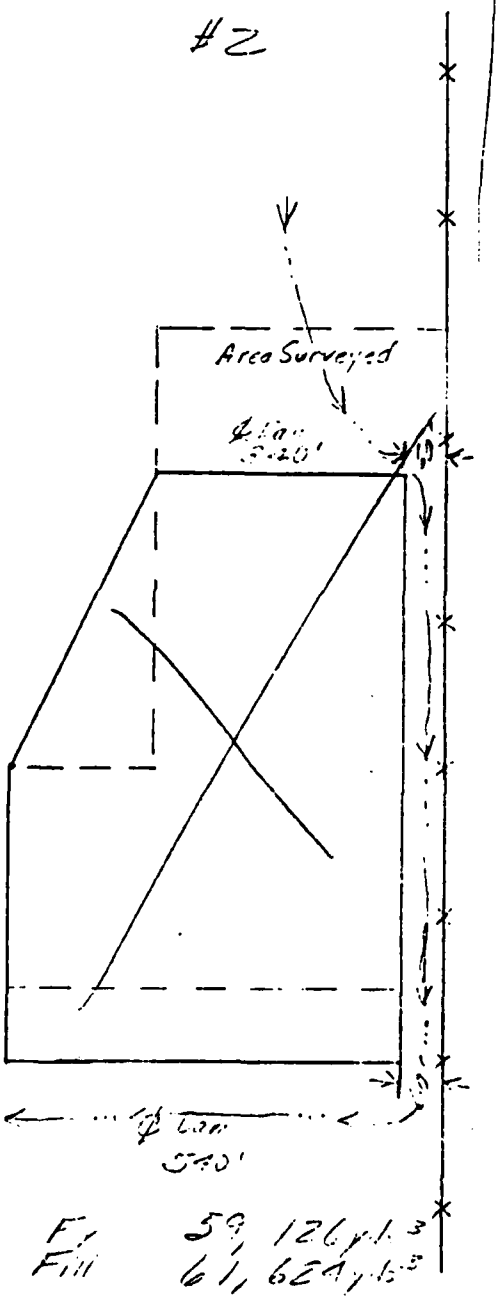
1910. F Kohl - Hudson C.

Irrig Reservoir Pump No. - North Dam



Er 51,503 Cu yds
Fill 57,972 Cu yds

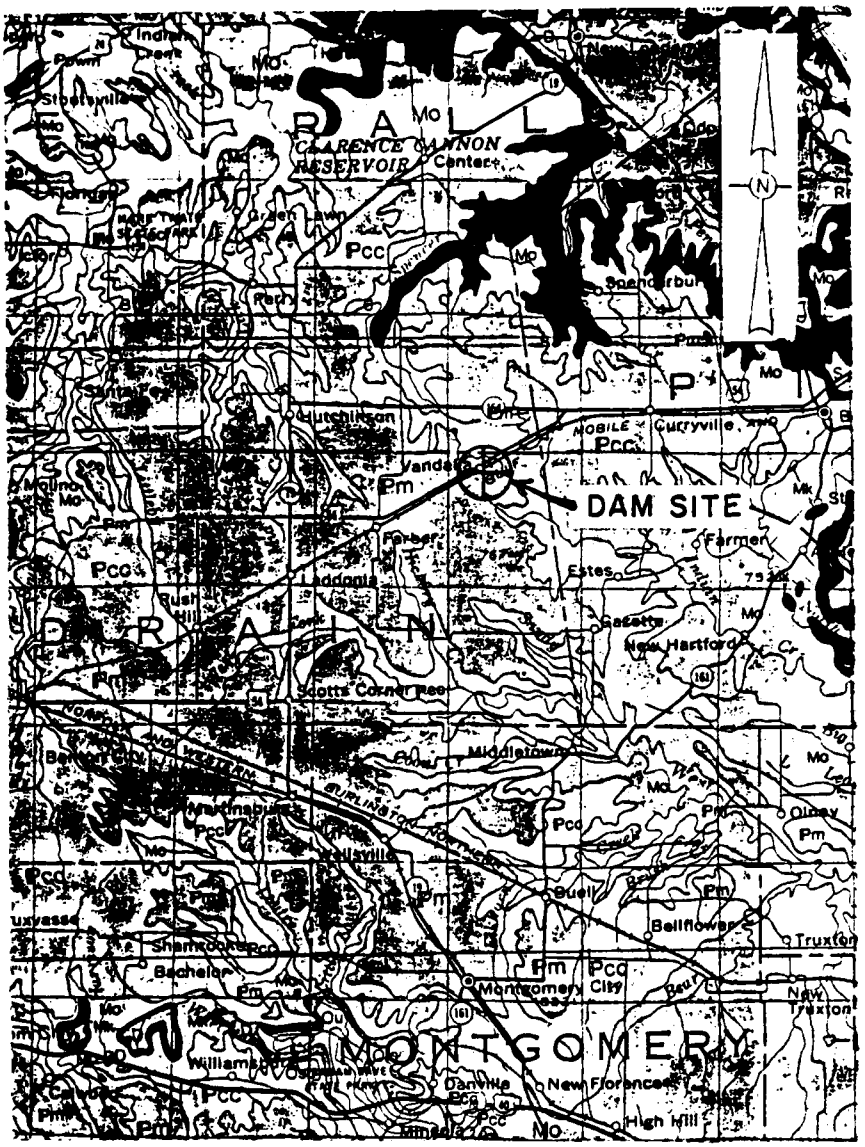
Storage 110 Ac Ft
depth 10 ft.
Top El. 53
W. L. " 51
Bottom " 41



Er 59,126 cu. yds
Fill 61,624 cu. yds

Storage 110 Ac-Ft
depth 10 ft.
Top El. 53
W.L. " 51
Bottom " 41

PLATE 4



SCALE

10 0 10 20 30 40 Miles

⊕ LOCATION OF DAM

NOTE: LEGEND OF THIS DAM IS ON PLATE 5

REFERENCE:

GEOLOGIC MAP OF MISSOURI
DEPARTMENT OF NATURAL RESOURCES
MISSOURI GEOLOGICAL SURVEY
KENNETH H. ANDERSON, 1979

REGIONAL GEOLOGICAL MAP OF KOHL IRRIGATION LAKE N DAM

KOHL IRRIGATION
LAKE NORTH DAM

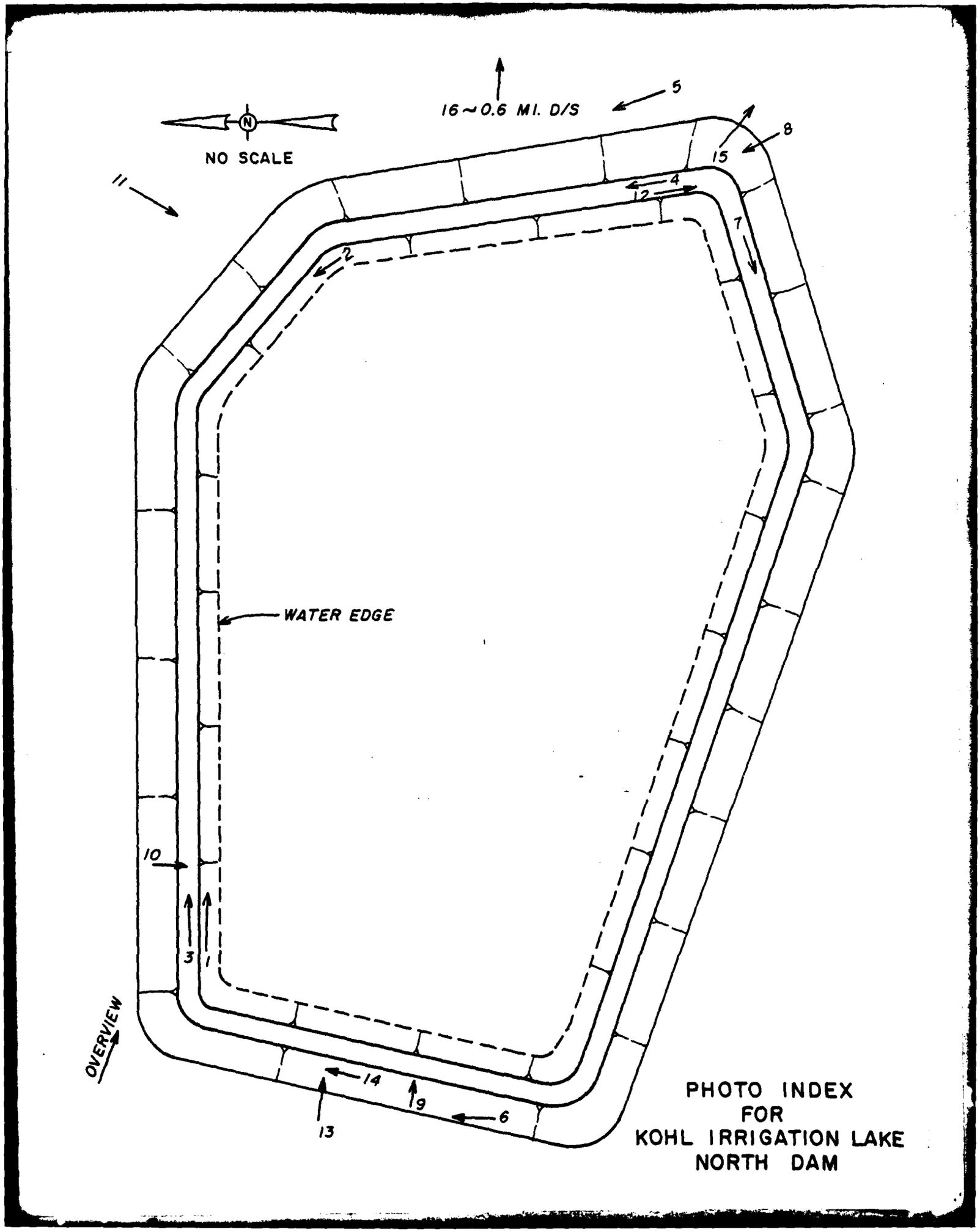
PLATE 5

LEGEND

PERIOD	SYMBOL	DESCRIPTION
QUATERNARY	Qal	ALLUVIUM: SAND, SILT, GRAVEL
PENNSYLVANIAN	PPwm	PLEASANTON GROUP: CYCLIC DEPOSITS OF SANDSTONE SHALE AND LIMESTONE
	Pm	MARMATON GROUP: CYCLIC DEPOSITS OF SHALE, LIMESTONE AND SANDSTONE
	Pcc	CHEROKEE GROUP: CYCLIC DEPOSITS OF SHALE, LIMESTONE AND SANDSTONE
MISSISSIPPIAN	Mo	KEOKUK - BURLINGTON FORMATION: CHERTY GRAYISH BROWN SANDY LIMESTONE
	Mk	CHOUTEAU GROUP: HANNIBAL AND BACHELOR FORMATION (SANDSTONE SHALE, CHERTY LIMESTONE, DOLOMITE)
SILURIAN	S	BOWLING GREEN LIMESTONE
ORDOVICIAN	Ou	NOIX LIMESTONE
	Odp	DECORAH FORMATION: GREEN TO GRAY CALCAREOUS SHALE WITH THIN FOSSILIFEROUS LIMESTONE

APPENDIX A

PHOTOGRAPHS


16 ~ 0.6 MI. D/S
5
N
NO SCALE
11
15
8
4
12
7
2
WATER EDGE
10
3
1
OVERVIEW
14
9
6
13
PHOTO INDEX
FOR
KOHL IRRIGATION LAKE
NORTH DAM

Kohl Irrigation Lake North Dam

Photographs

Photo 1 - Overview of the inside face of the dam taken from the northwest corner of the dam.

Photo 2 - View of the inside face of the dam showing the scarp and bench due to wave erosion and the outlet pipe of the refill pump.

Photo 3 - View of the top of the dam from the northwest corner of the embankment showing the vegetative cover. Note the stream channel along the toe of the slope.

Photo 4 - View of the top of the dam from the southeast corner of the embankment showing the damage to the embankment due to vehicular traffic.

Photo 5 - View of the outside face of the embankment taken from the southeast corner of the dam. Note the wet area in the center of the photo.

Photo 6 - View of the outside face of the western portion of the embankment. Note the stream channel at the toe of the slope.

Photo 7 - Close-up view of a crack on the top of the embankment.

Photo 8 - View of vehicular traffic damage to the outside face of the embankment at the southeast corner.

Photo 9 - View of erosional gullies on the outside face of the western portion of the embankment.

Photo 10 - View of an erosional gully on the outside face of the northern portion of the embankment.

Photo 11 - View of the refill pump's wet well and motor.

Photo 12 - View of the portable irrigation pump used at the dam site.

Photo 13 - View of the housing for the 10-inch, low-level outlet gate valve and the partially plugged outlet end of the 10-inch pipe.

Photo 14 - View of the gate valve that controls the 10-inch, low-level outlet.

Photo 15 - View of the downstream channel.

Photo 16 - View of a dwelling downstream from the dam that appears to be in the downstream hazard zone.

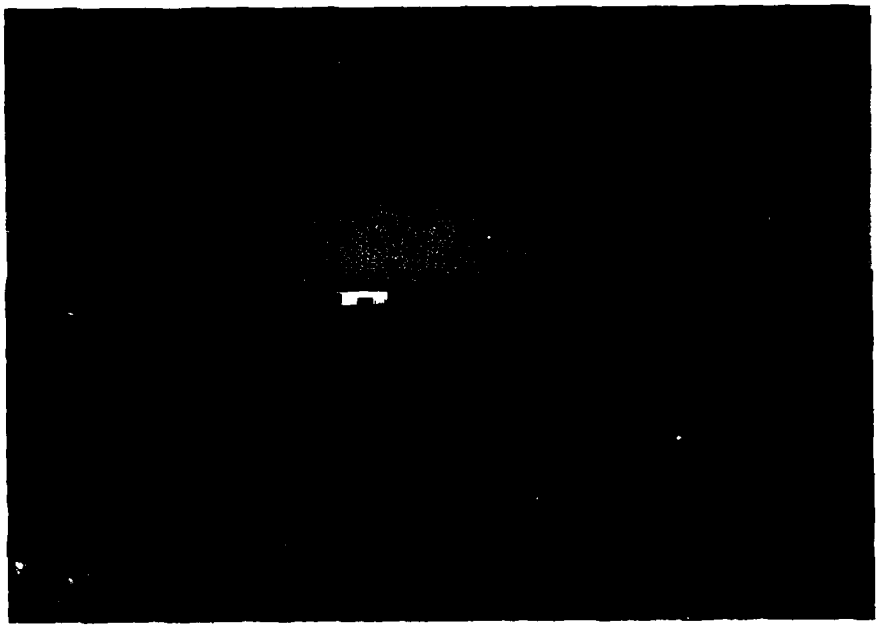


Photo 1

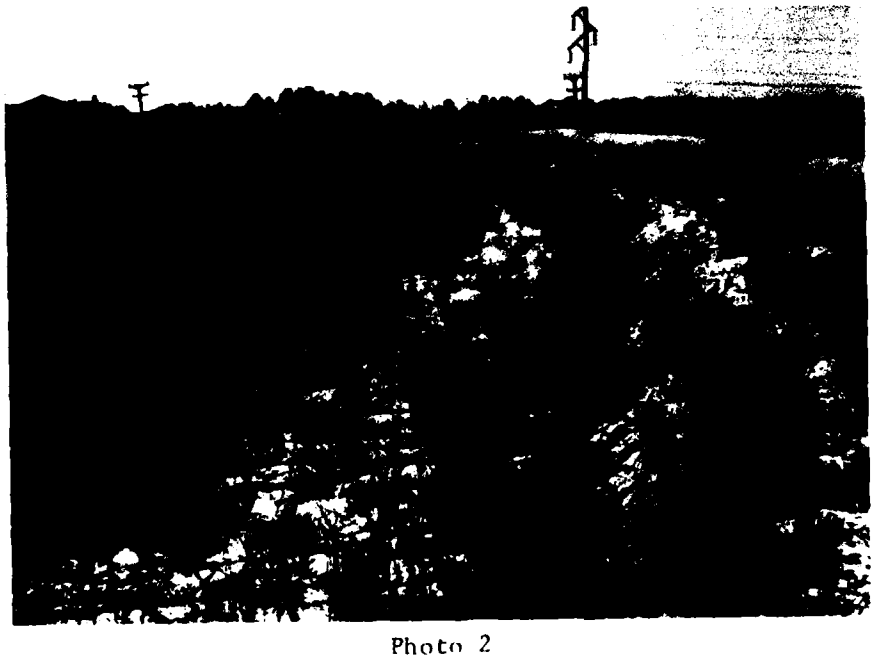


Photo 2

Photo 3

Photo 4

Photo 5

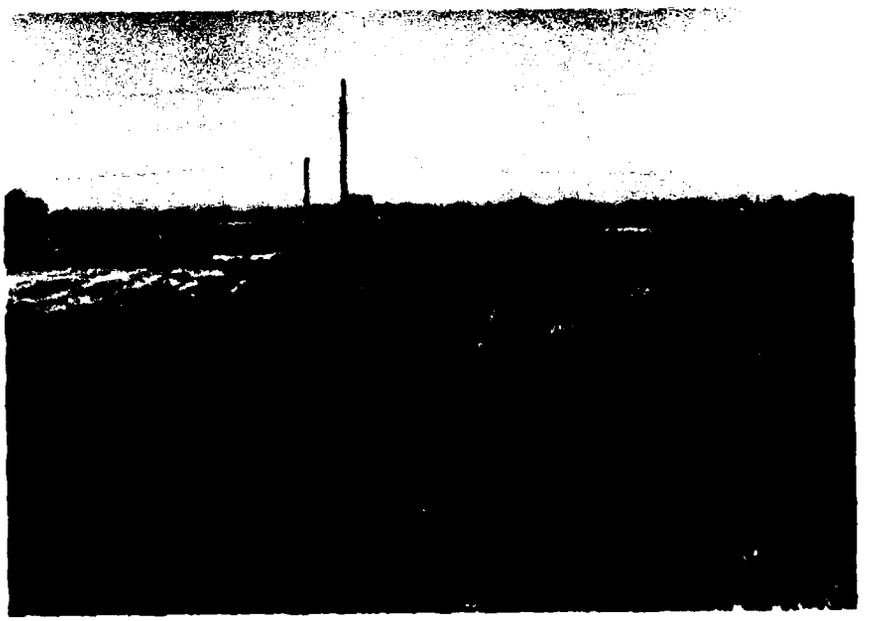


Photo 6

Kohl Irrigation Lake North Dam

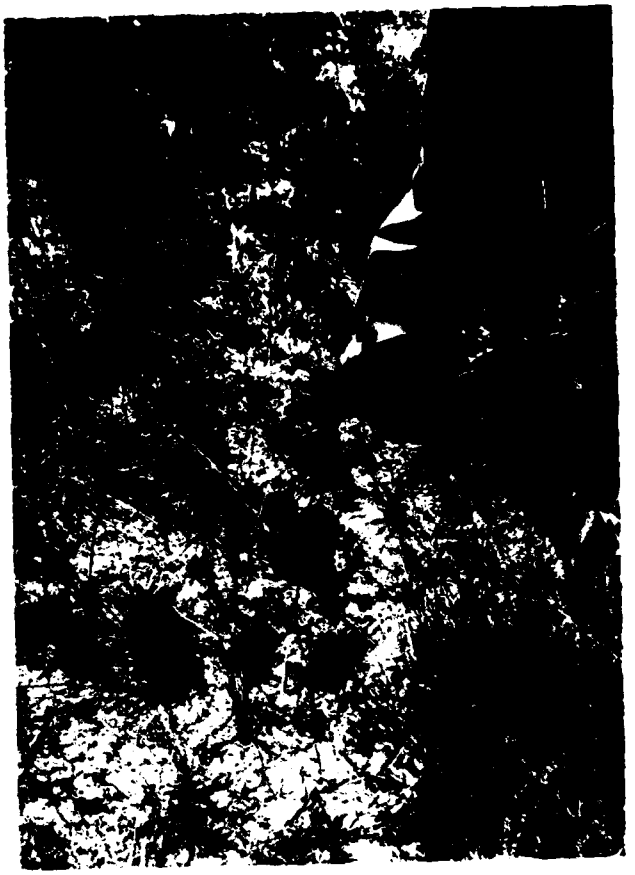


Photo 7

Photo 8

Photo 9

Photo 10

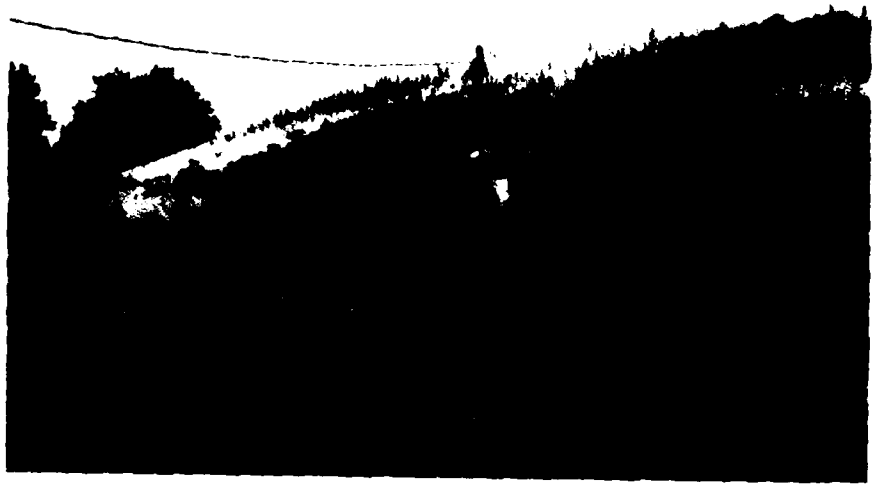


Photo 11

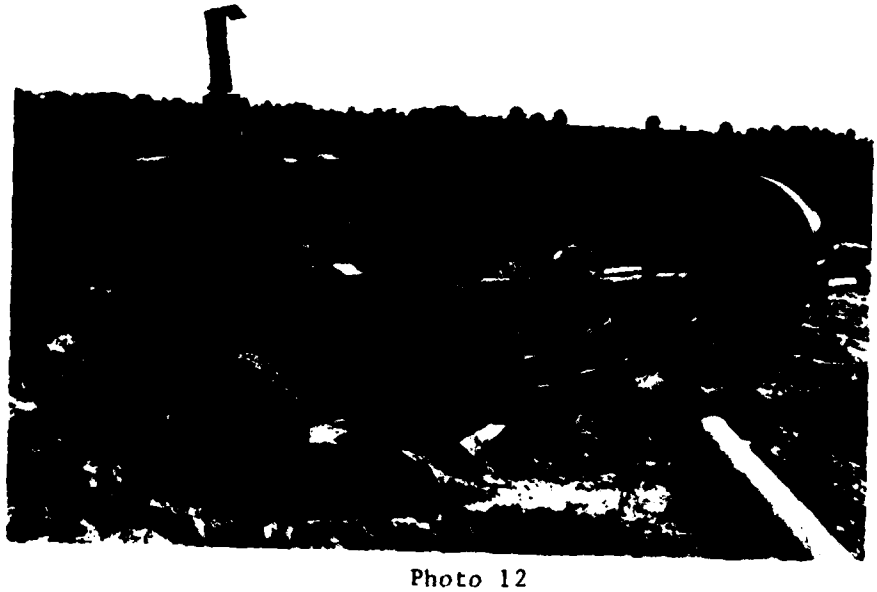


Photo 12

Kohl Irrigation Lake North Dam

Photo 13

Photo 14

Photo 15

Photo 16

APPENDIX B

HYDROLOGIC AND HYDRAULIC COMPUTATIONS

ECI-4 **PRC ENGINEERING CONSULTANTS, INC.**

DAM SAFETY INSPECTION / MISSOURI — SHEET N 1 OF 3

DAM NAME: KOHL IRR. LAKE NORTH 11210 — JOB NO. 1263

PROBABLE MAXIMUM PRECIPITATION — BY FZ (W. MAS) DATE 8/13/81

DETERMINATION OF PMP

1) Determine drainage area of the basin

D.A. = 8.73 Ac

2) Determine PMP Index Rainfall (for D.A. = 200 sq. mi. & 24 hr. duration)

Location of centroid of basin,

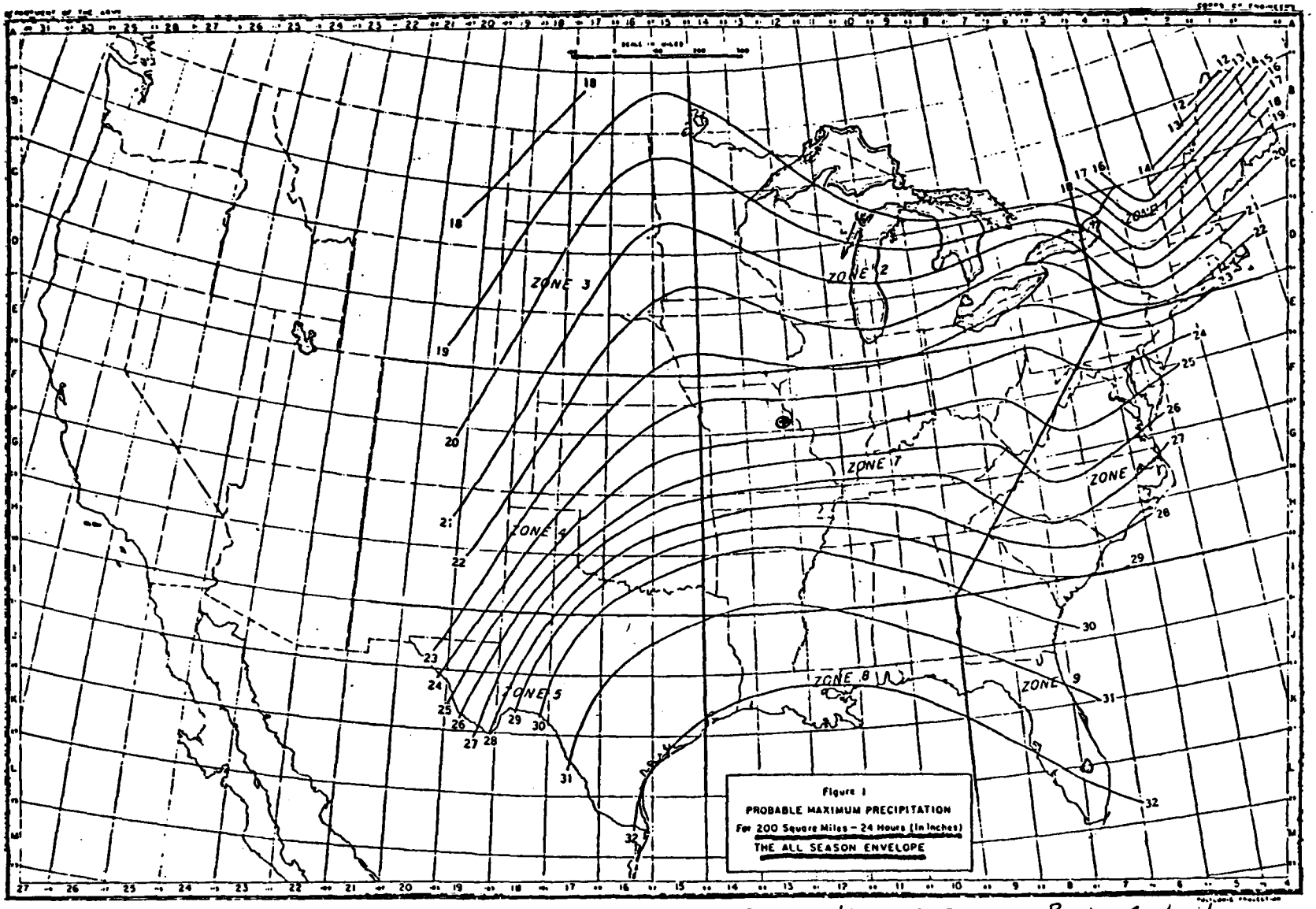
Long. = 91°29'24" Lat. = 39°17'34"

PMP = 24.6 (from Fig. 1, HMR 33)

Zone = 7

3) Determine basin rainfall in terms of percentage of PMP Index Rainfall for various durations. (from Fig. 2, HMR 33)

Duration (Hrs.)	Percent of Index Rainfall (%)	Total Rainfall (Inches)
6	100	24.6
12	120	29.5
24	130	32.0
48	140	34.4



B-3

20

● Location of Drainage Basin Centroid

KOHL IRRIGATION LAKE NORTH DAM
(MO. 11210)

2 of 3

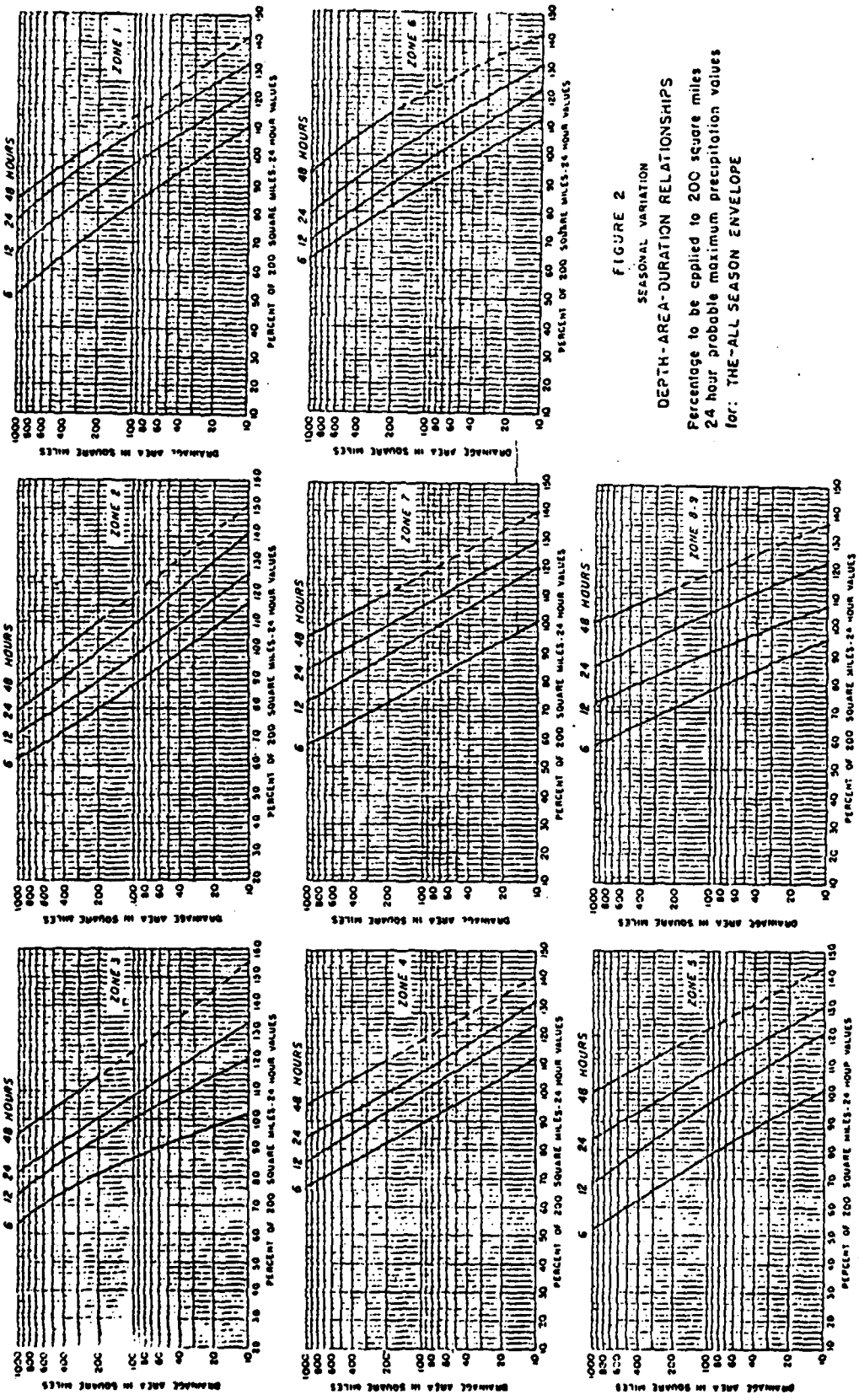
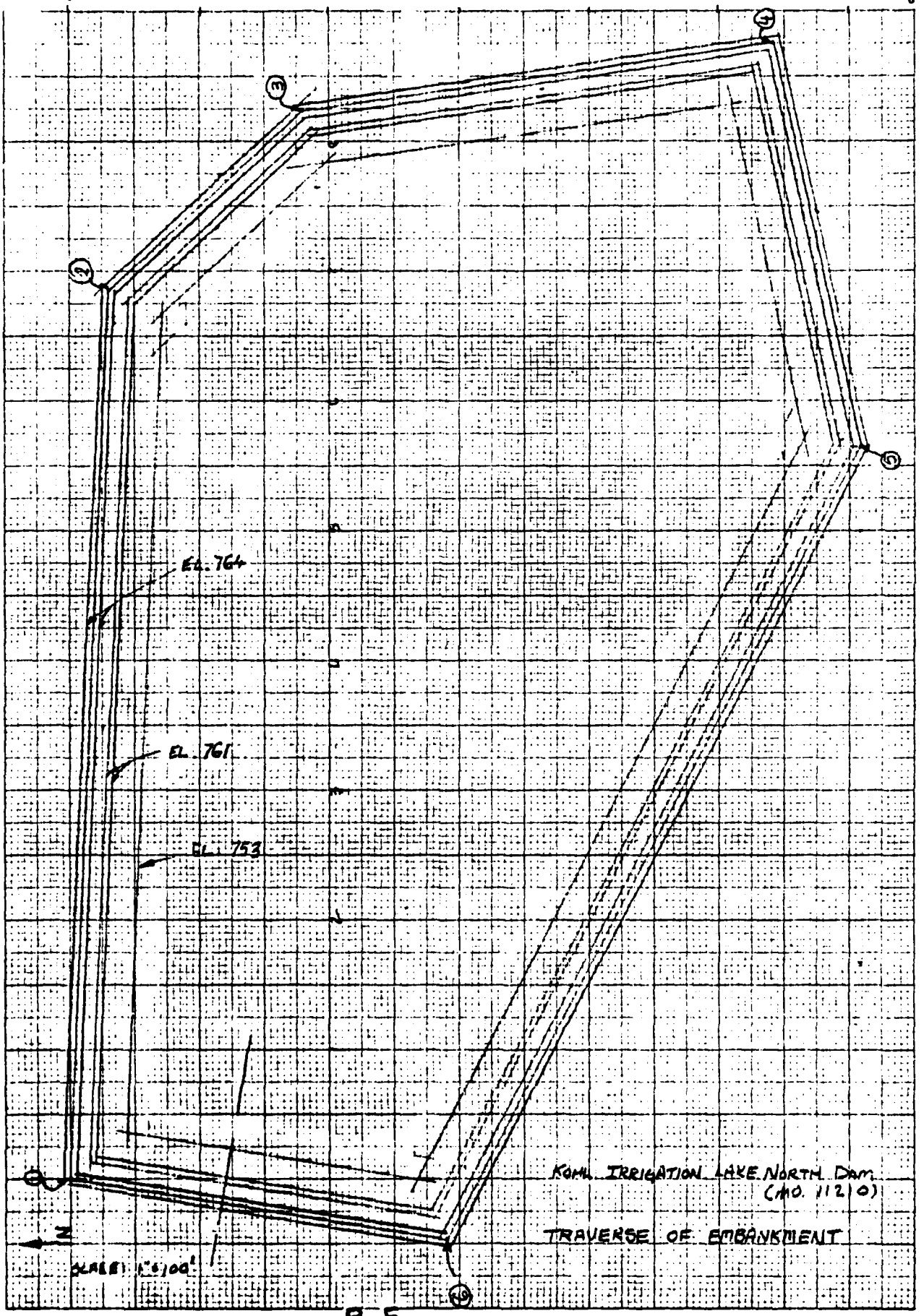


FIGURE 2
SEASONAL VARIATION
DEPTH-AREA-DURATION RELATIONSHIPS
Percentage to be applied to 200 square miles
24 hour probable maximum precipitation values
for: THE-ALL SEASON ENVELOPE



EC1-4 **PRC ENGINEERING CONSULTANTS, INC.**

SHEET NO. 2 OF 4

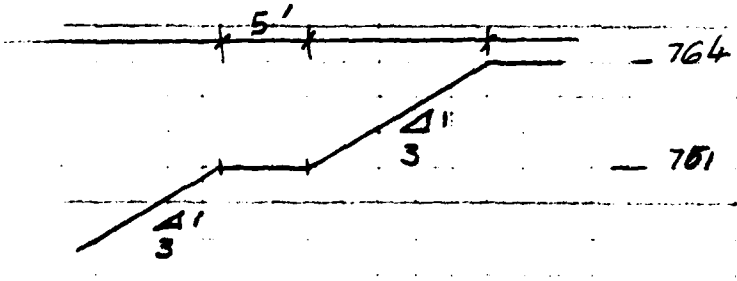
DAM SAFETY INSP./MISSOURI — JOB NO. 1263

KOHL IRRIGATION LAKE NORTH (11210) — BY FZ DATE Aug 80

By adjustment of note we obtain

Point	NORTH	EAST	DISTANCE	AZIMUTH
①	0	0		
			686.1	92.5°
②	- 30.2	685.5		
			203.4	137.6°
③	- 180.2	822.7		
			363.7	171.5°
④	- 540.0	876.2		
			318.9	257.8°
⑤	- 607.2	564.5		
			688.3	297.3°
⑥	- 291.9	-47.4		
	AREA = 9.09 Ac		295.8	9.2°

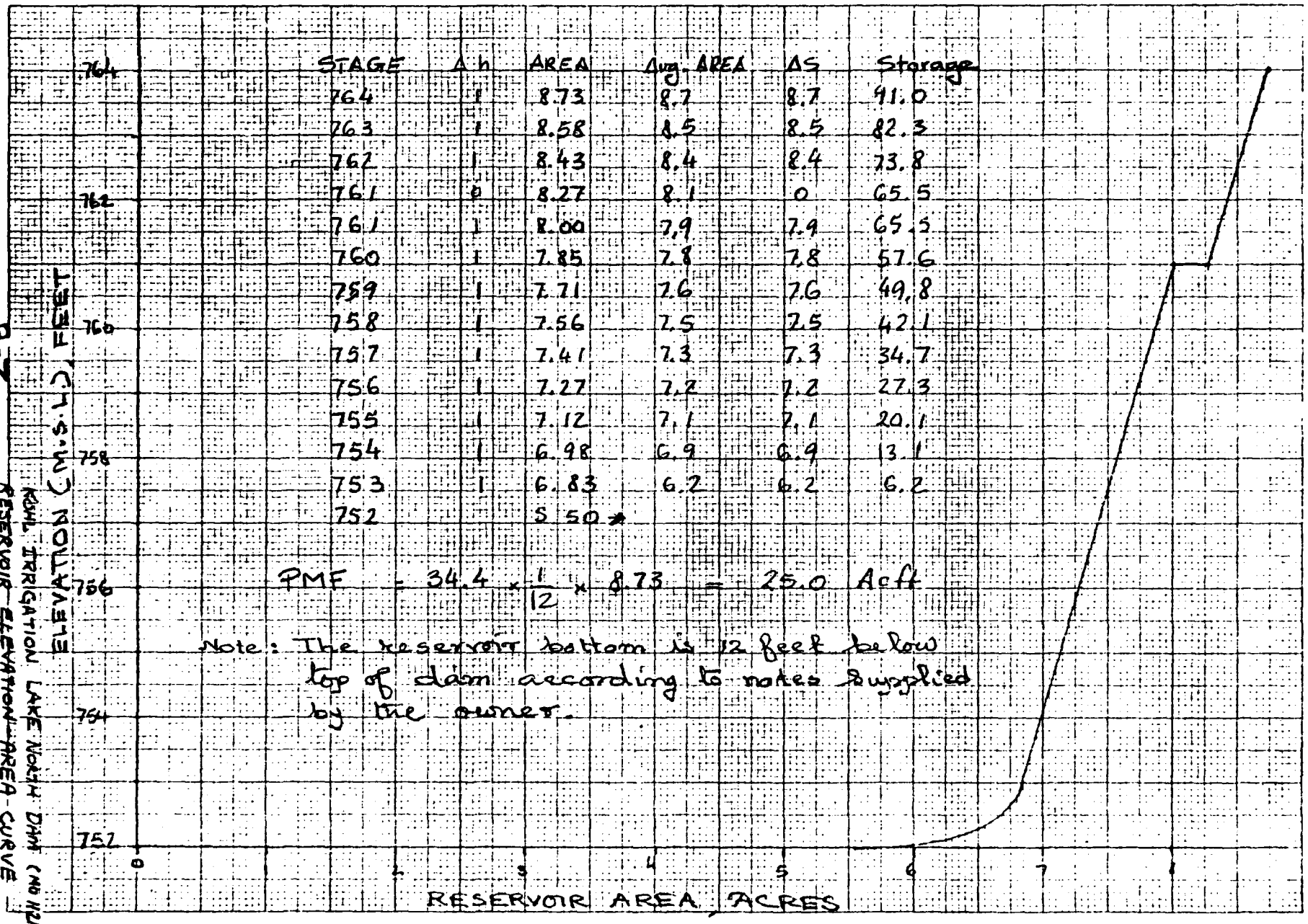
	EL 764		EL 761		EL 761		EL 753	
	NORTH	EAST						
①	-5	+4	-14	12	-20	17	-44	36
②	-35	662	-45	678	-50	675	-70	667
③	-180	812	-188	810	-186	805	-197	783
④	-538	870	-530	859	-527	853	-510	828
⑤	-602	564	-592	566	-587	566	-565	572
⑥	-287	-41	-282	-30	-278	-25	-268	0
ft² AREA	380.328		360.365		348 309		≈297 700	
	8.73		8.27		8.00 Ac		6.83	



STAGE	Δh	AREA	Avg. AREA	ΔS	Storage
764	1	8.73	8.7	8.7	91.0
763	1	8.58	8.5	8.5	82.3
762	1	8.43	8.4	8.4	73.8
761	0	8.27	8.1	0	65.5
761	1	8.00	7.9	7.9	65.5
760	1	7.85	7.8	7.8	57.6
759	1	7.71	7.6	7.6	49.8
758	1	7.56	7.5	7.5	42.1
757	1	7.41	7.3	7.3	34.7
756	1	7.27	7.2	7.2	27.3
755	1	7.12	7.1	7.1	20.1
754	1	6.98	6.9	6.9	13.1
753	1	6.83	6.2	6.2	6.2
752		5.50 *			

PMF = $34.4 \times \frac{1}{12} \times 8.73 = 25.0$ Acft

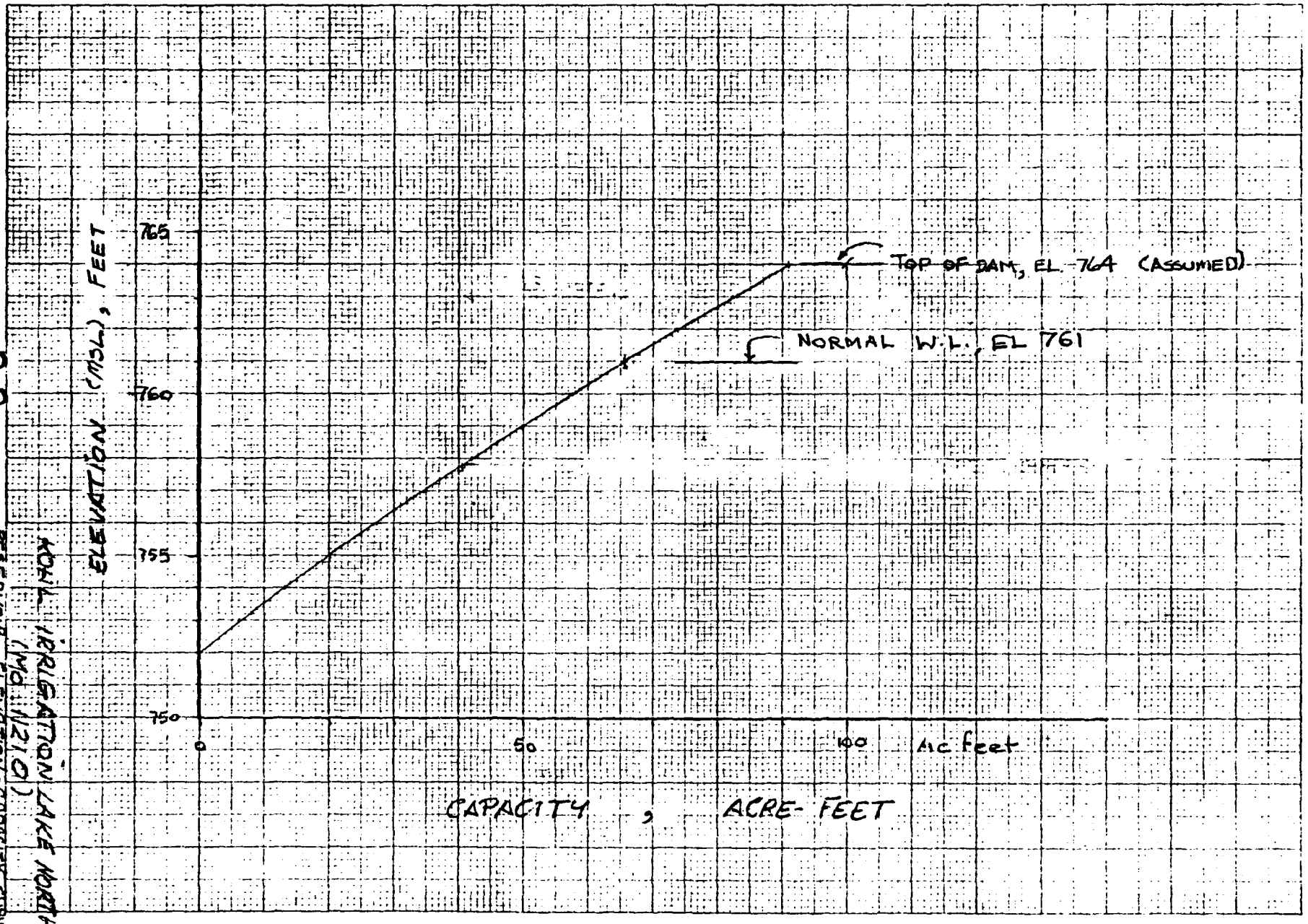
Note: The reservoir bottom is 12 feet below top of dam according to notes supplied by the owner.



B-7

KOWL IRRIGATION LAKE NORTH DAM (NO H2O)
RESERVOIR ELEVATION-AREA-CURVE

384



B-8

KOHL IRRIGATION LAKE NORTH (MOD. 11/21/01)
RESERVOIR ELEVATION-CAPACITY CURVE